WHAT'S HAPPENING IN SEMICONDUCTORS—THE NEXT CHAPTER

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We recently wrote about semiconductors from the perspective of capital spending and government policies aimed at encouraging further capital spending and, ultimately, semiconductor independence.

However, we'd be remiss if we did not at least touch on some of the current geopolitical issues.

A Simplified Look at the Semiconductor Supply Chain

By simplifying a rather complex set of interrelationships among countries, we can picture a triangle with three distinct corners[1]:

- **Foundries:** These companies are manufacturing the physical chips. There are not too many individual players, as the capital expenditure to enter this space is extremely high. Additionally, they don't all have the same capabilities. Taiwan Semiconductor Manufacturing Co. (TSMC) is well-known for being able to reliably manufacture the most advanced chips in the world. Samsung Electronics, Intel and GlobalFoundries are other important players.
- **Intellectual Property:** These companies make and sell different chip layouts and designs. ARM, the company currently owned by SoftBank, is one example with a huge presence in the internet of things (IoT).
- **Electronic Design Automation (EDA) Tools:** EDA was worth only $10 billion in 2021, a small part of the overall $595-billion semiconductor market, but it is essential if chip manufacturers are to determine whether a design is feasible prior to production. Cadence, Synopsys and Mentor Graphics are the three leading players in this space. Together, they control about 70% of the global market.

Behind each of these points on the triangle is a lot of history embedded as experience, and it is important to recognize this since it is this that makes it particularly challenging for an outside player—such as China—to just copy it.

The ASML Example

Lithography is the term used for the practice of etching the appropriate designs on the silicon that allow for the functional operation of transistors. Simply put, more transistors spaced more closely together means a more efficient and capable chip. Today's Apple M1 chip contains 16 billion transistors.[2]

The degree of precision engineering required to be able to put 16 billion transistors on something that is not the size of multiple city blocks, much less something that can fit in a laptop or smartphone, is one of the most impressive feats of human ingenuity the world has ever seen. The short version of the story is that a company in the Netherlands, ASML, was in a position to take a big risk in the 2000s—the pursuit of extreme ultraviolet lithography (EUV).

EUV was necessary because shorter wavelengths of light were needed to shave, almost atom by atom, away from the silicon to make the transistors small enough, basically 5 nanometers. This light is generated by flashing a specific type of laser 50,000 times per second at molten tin.[3]

Developing EUV was so capital intensive that only a single company did it: ASML. Components for the machines that do this fill four 747 airplanes and are sourced from specific companies all over the world. Operating the machines at scale requires an incredible depth of experience.[4]

Given the flavor of the topic, you have probably already guessed the geopolitical implications. Some of the components of the EUV machines do come from the United States. Then, there is the relationship between the U.S. and Dutch governments. As a result of those discussions and where we are presently, EUV machines are not being sent to China.

The Nvidia Case

In August 2022, the U.S. took a another step to limit China's AI ambitions through further restrictions on the export of very specific semiconductors[5]:

- Nvidia will be restricted from selling the A100 graphics processing unit into China, Hong Kong and Russia.
- Nvidia will also be restricted from selling its forthcoming H100 series of graphics chips into these same markets.
- Users of the A100 include Alibaba, Tencent and Baidu—the companies that provide some of China's largest cloud computing infrastructure.

Nvidia is the most visible company with respect to these types of chips, and as of this writing had the largest market cap among the semiconductor companies. It would not surprise us if other firms with chips of similar types of capabilities could be named in the future.

Conclusion: Can China 'Go it Alone'?

We might take a step back at this point and think, wait, China has massive resources. Why doesn't it just make its own chips? We don't discount the fact that China absolutely could make its own chips, but it would be more a question of how long it would take and how advanced those chips could be.

The EUV process was something that took both massive investment and about 20 years. ASML is able to manufacture the machines that it does and support companies like TSMC operating at scale because they have had the benefit of learning from all the mistakes along the way. China can certainly make efforts along the path, but simply spending money is not going to lead to an effective EUV process that can manufacture the most cutting edge chips at scale—the key being, at scale without a high defect rate.

During the four years ended 2024, China is slated to complete 31 major semiconductor factories. By 2025, 40% of the world's capacity to produce chips with 28-nanometer nodes is expected to be in China.[6] This tells us that China is making big investments away from the absolute cutting edge—and we have to remember that the world does need those chips as well.

It will be very difficult for any country to fully take on all aspects of the semiconductor supply chain, but we are seeing notable efforts to that end in 2022 that will likely continue.

For investors, few things are as clearly visible than that we will continue to need lots and lots of semiconductors globally well into the future. We will also want them to continue to increase in capability. WisdomTree's Artificial Intelligence and Innovation Fund (WTAI) is a way to gain significant exposure to semiconductor firms that focus on specific types of AI applications with their hardware, thereby capitalizing on the expanding demand for semiconductors within the broader AI context.

[1] Source: Zeyi Yang, "Inside the Software that Will Become the Next Battle Front in US-China Chip War," *MIT Technology Review*, 8/18/22.

[2] Source: https://en.wikipedia.org/wiki/Apple_M1

[3] Source: Clive Thompson, "Inside the Most Complicated Machine on the Planet." *MIT Technology Review*, November/December 2021.

[4] Source: Thompson, November/December 2021.

[5] Source: Liza Lin & Dan Strumpf, "Latest U.S. Chip Curbs Deliver Setback to China's AI Ambitions," *Wall Street Journal*, 9/1/22.

[6] Source: Dan Strumpf & Liza Lin, "China Bets Big on Basic Chips in Self-Sufficiency Push," *Wall Street Journal*, 7/24/22.

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DEFINITIONS

Semiconductor : A semiconductor is a material product usually comprised of silicon, which conducts electricity more than an insulator, such as glass, but less than a pure conductor, such as copper or aluminum. Their conductivity and other properties can be altered with the introduction of impurities, called doping, to meet the specific needs of the electronic component in which it resides.

Capital expenditures : Spending by a company typically made to enhance longer-term productive capacity.